

BISON References

Fuels Modeling & Simulation Department
Idaho National Laboratory
Idaho Falls, ID

11 October 2016

Journal Papers

- B. W. Spencer, R. L. Williamson, D. S. Stafford, S. R. Novascone, J. D. Hales, and G. Pastore, "3D modeling of missing pellet surface defects in BWR fuel," *Nuclear Engineering and Design*, vol. 307, pp. 155–171, 2016. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0029549316302187>
- R. L. Williamson, K. A. Gamble, D. M. Perez, S. R. Novascone, G. Pastore, R. J. Gardner, J. D. Hales, W. Liu, and A. Mai, "Validating the BISON fuel performance code to integral LWR experiments," *Nuclear Engineering and Design*, vol. 301, pp. 232–244, 2016. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0029549316000789>
- S. R. Novascone, B. W. Spencer, J. D. Hales, and R. L. Williamson, "Evaluation of coupling approaches for thermomechanical simulations," *Nuclear Engineering and Design*, vol. 295, pp. 910–921, 2015. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0029549315002757>
- X. Wu, T. Kozlowski, and J. D. Hales, "Neutronics and fuel performance evaluation of accident tolerant fuel cladding under normal operation conditions," *Annals of Nuclear Energy*, vol. 85, pp. 763–775, Nov. 2015. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0306454915003461>
- D. S. Stafford, "Multidimensional simulations of hydrides during fuel rod lifecycle," *J. Nucl. Mater.*, vol. 466, no. 0, pp. 362–372, 2015. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0022311515300623>
- J. D. Hales, M. R. Tonks, K. Chockalingam, D. M. Perez, S. R. Novascone, B. W. Spencer, and R. L. Williamson, "Asymptotic expansion homogenization for multiscale nuclear fuel analysis," *Computational Materials Science*, vol. 99, pp. 290–297, Mar. 2015. [Online]. Available: <http://dx.doi.org/10.1016/j.commatsci.2014.12.039>
- J. D. Hales, M. R. Tonks, F. N. Gleicher, B. W. Spencer, S. R. Novascone, R. L. Williamson, G. Pastore, and D. M. Perez, "Advanced multiphysics coupling for LWR fuel performance analysis," *Ann. Nuclear Energy*, vol. 84, pp. 98–110, Oct. 2014. [Online]. Available: <http://dx.doi.org/10.1016/j.anucene.2014.11.003>
- G. Pastore, L. P. Swiler, J. D. Hales, S. R. Novascone, D. M. Perez, B. W. Spencer, L. Luzzi, P. Van Uffelen, and R. L. Williamson, "Uncertainty and sensitivity analysis of fission gas behavior in engineering-scale fuel modeling," *Journal of Nuclear Materials*, vol. 456, pp. 398–408, 2015. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0022311514006771>

- H. Huang, B. Spencer, and J. Hales, “Discrete element method for simulation of early-life thermal fracturing behavior in ceramic nuclear fuel pellets,” *Nuclear Engineering and Design*, vol. 278, pp. 515 – 528, 2014. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0029549314004440>
- O. Courty, A. T. Motta, and J. D. Hales, “Modeling and simulation of hydrogen behavior in Zircaloy-4 fuel cladding,” *J. Nucl. Mater.*, vol. 452, pp. 311–320, 2014. [Online]. Available: <http://dx.doi.org/10.1016/j.jnucmat.2014.05.013>
- J. D. Hales, S. R. Novascone, B. W. Spencer, R. L. Williamson, G. Pastore, and D. M. Perez, “Verification of the BISON fuel performance code,” *Ann. Nuclear Energy*, vol. 71, pp. 81–90, Sep. 2014. [Online]. Available: <http://dx.doi.org/10.1016/j.anucene.2014.03.027>
- M. C. Teague, M. R. Tonks, S. R. Novascone, and S. R. Hayes, “Microstructural modeling of thermal conductivity of high burnup mixed oxide fuel,” *J. Nucl. Mater.*, vol. 444, pp. 161–169, 2014. [Online]. Available: <http://dx.doi.org/10.1016/j.jnucmat.2013.09.035>
- J. D. Hales, R. L. Williamson, S. R. Novascone, D. M. Perez, B. W. Spencer, and G. Pastore, “Multidimensional multiphysics simulation of TRISO particle fuel,” *J. Nucl. Mater.*, vol. 443, pp. 531–543, Nov. 2013. [Online]. Available: <http://dx.doi.org/10.1016/j.jnucmat.2013.07.070>
- M. R. Tonks, P. C. Millett, P. Nerikar, S. Du, D. Andersson, C. R. Stanek, D. Gaston, D. Andrs, and R. Williamson, “Multiscale development of a fission gas thermal conductivity model: Coupling atomic, meso and continuum level simulations,” *J. Nucl. Mater.*, vol. 440, pp. 193–200, 2013. [Online]. Available: <http://dx.doi.org/10.1016/j.jnucmat.2013.05.008>
- R. L. Williamson, J. D. Hales, S. R. Novascone, M. R. Tonks, D. R. Gaston, C. J. Permann, D. Andrs, and R. C. Martineau, “Multidimensional multiphysics simulation of nuclear fuel behavior,” *J. Nucl. Mater.*, vol. 423, pp. 149–163, 2012. [Online]. Available: <http://dx.doi.org/10.1016/j.jnucmat.2012.01.012>
- K. Chockalingam, M. R. Tonks, J. D. Hales, D. R. Gaston, P. C. Millett, and L. Zhang, “Crystal plasticity with Jacobian-free Newton–Krylov,” *Computational Mechanics*, pp. 1–11, 2012.
- D. Gaston, L. Guo, G. Hansen, H. Huang, R. Johnson, H. Park, R. Podgorney, M. Tonks, and R. Williamson, “Parallel algorithms and software for nuclear, energy, and environmental applications part i: Multiphysics algorithms,” *Communications in Computational Physics*, vol. 12, no. INL/JOU-10-20006, pp. 807–833, 2012.
- D. Gaston, L. Guo, G. Hansen, H. Huang, R. Johnson, D. Knoll, C. Newman, H. Park, R. Podgorney, M. Tonks, and R. Williamson, “Parallel algorithms and software for nuclear, energy, and environmental applications. part ii: Multiphysics software,” *Communications in Computational Physics*, vol. 12, no. INL/JOU-10-25162, pp. 834–865, 2012.
- J. D. Hales, S. R. Novascone, R. L. Williamson, D. R. Gaston, and M. R. Tonks, “Solving nonlinear solid mechanics problems with the Jacobian-free Newton Krylov method,” *CMES: Comput. Model. Eng. Sci.*, vol. 84, no. 2, pp. 123–154, 2012.

- R. L. Williamson, “Enhancing the ABAQUS thermomechanics code to simulate multipellet steady and transient LWR fuel rod behavior,” *J. Nucl. Mater.*, vol. 415, p. 74, 2011.
- C. Newman, G. Hansen, and D. Gaston, “Three dimensional coupled simulation of thermomechanics, heat, and oxygen diffusion in UO₂ nuclear fuel rods,” *J. Nucl. Mater.*, vol. 392, pp. 6–15, 2009.
- M. Tonks, D. Gaston, C. Permann, P. Millett, G. Hansen, and D. Wolf, “A coupling methodology for mesoscale-informed nuclear fuel performance codes,” *Nucl. Engrg. Design*, vol. 240, no. 10, pp. 2877–2883, 2010.

Conference Papers

- K. A. Gamble and J. D. Hales, "Preliminary modeling of accident tolerant fuel concepts under accident conditions," in *TopFuel 2016 Conference Proceedings*, Boise, ID, 11–16 September 2016.
- F. Gleicher, J. Ortensi, M. DeHart, Y. Wang, S. Schunert, S. Novascone, J. Hales, R. Williamson, A. Slaughter, C. Permann, D. Andrs, and R. Martineau, "The application of Mammoth for a detailed tightly couple fuel pin simulation with station blackout," in *TopFuel 2016 Conference Proceedings*, Boise, ID, 11–16 September 2016.
- J. D. Hales and K. A. Gamble, "Multiscale modeling of accident tolerant fuels under the NEAMS ATF program," in *2016 ANS Annual Meeting*, New Orleans, LA, 12–16 June 2016.
- , "Modeling accident tolerant fuel concepts," in *Enlarged Halden Programme Group Meeting*, Oslo/Fornebu, Norway, 8–13 May 2016.
- A. Casagrande, B. W. Spencer, G. Pastore, S. R. Novascone, J. D. Hales, R. L. Williamson, and R. C. Martineau, "Determination of experimental fuel rod parameters using 3D modeling of PCMI with MPS defects," in *Enlarged Halden Programme Group Meeting*, Oslo/Fornebu, Norway, 8–13 May 2016.
- R. L. Williamson, G. Pastore, S. R. Novascone, B. W. Spencer, and J. D. Hales, "Modelling of LOCA tests with the BISON fuel performance code," in *Enlarged Halden Programme Group Meeting*, Oslo/Fornebu, Norway, 8–13 May 2016.
- G. Pastore, J. D. Hales, S. R. Novascone, B. W. Spencer, and R. L. Williamson, "Modelling of gadolinium fuel test IFA-681 using the bison code," in *Enlarged Halden Programme Group Meeting*, Oslo/Fornebu, Norway, 8–13 May 2016.
- J. D. Hales and K. A. Gamble, "Preliminary evaluation of FeCrAl cladding and U-Si fuel for accident tolerant fuel concepts," in *TopFuel 2015 Conference Proceedings*, Zurich, Switzerland, 13–17 September 2015.
- S. M. Bragg-Sitton, B. J. Merrill, and J. Hales, "Evaluation of enhanced accident tolerant LWR fuels," in *TopFuel 2015 Conference Proceedings*, Zurich, Switzerland, 13–17 September 2015.
- G. Pastore, S. R. Novascone, R. L. Williamson, J. D. Hales, B. W. Spencer, and D. S. Stafford, "Modelling of fuel behaviour during loss-of-cooling accidents using the BISON code," in *TopFuel 2015 Conference Proceedings*, Zurich, Switzerland, 13–17 September 2015.

- R. J. Gardner, S. R. Novascone, D. M. Perez, R. L. Williamson, J. D. Hales, and W. Liu, “Improving the accuracy of PCMI simulations with more realistic geometry and material models,” in *TopFuel 2015 Conference Proceedings*, Zurich, Switzerland, 13–17 September 2015.
- W. Liu, R. Montgomery, C. Tomé, C. Stanek, and J. Hales, “VPSC implementation in BISON-CASL code for modeling large deformation problems,” in *ANS MC2015 – Joint International Conference on Mathematics and Computation (M&C), Supercomputing in Nuclear Applications (SNA) and the Monte Carlo (MC) Method*, Nashville, TN, April 19–23 2015.
- J. D. Hales, P. G. Medvedev, S. R. Novascone, D. M. Perez, and R. L. Williamson, “Analysis of double-encapsulated fuel rods,” in *Enlarged Halden Programme Group Meeting*, Røros, Norway, 7–12 September 2014.
- G. Pastore, D. Pizzocri, J. D. Hales, S. R. Novascone, D. M. Perez, B. W. Spencer, R. L. Williamson, P. V. Uffelen, and L. Luzzi, “Modeling of transient fission gas behavior in oxide fuel and application to the BISON code,” in *Enlarged Halden Programme Group Meeting*, Røros, Norway, 7–12 September 2014.
- R. L. Williamson, J. D. Hales, S. R. Novascone, G. Pastore, D. M. Perez, B. W. Spencer, and R. C. Martineau, “Overview of the BISON multidimensional fuel performance code,” in *IAEA Technical Meeting: Modeling of Water-Cooled Fuel Including Design-Basis and Severe Accidents*, Chengdu, China, October 28–November 1, 2013.
- G. Pastore, J. D. Hales, S. R. Novascone, D. M. Perez, B. W. Spencer, and R. L. Williamson, “Analysis of fission gas release in LWR fuel using the BISON code,” in *2013 LWR Fuel Performance Meeting – TopFuel*, Charlotte, NC, September 15–19 2013.
- W. Liu, J. Rashid, D. Sunderland, R. Montgomery, C. Stanek, B. Wirth, J. Hales, and R. Williamson, “Numerical method of modeling creep of zirconium-alloy cladding in a multi-physics fuel performance code,” in *2013 LWR Fuel Performance Meeting – TopFuel*, Charlotte, NC, September 15–19 2013.
- N. Capps, D. Sunderland, W. Liu, R. Montgomery, J. Hales, C. Stanek, and B. Wirth, “Verification and benchmarking of Peregrine against Halden fuel rod data and FALCON,” in *2013 LWR Fuel Performance Meeting – TopFuel*, Charlotte, NC, September 15–19 2013.
- J. D. Hales, D. M. Perez, R. L. Williamson, S. R. Novascone, B. W. Spencer, and G. Pastore, “Nuclear fuel modeling with BISON,” in *Fuels & Materials Summer School on Principles of Fuel Behaviour Modelling and Practical Applications*. Halden, Norway: OECD Halden Reactor Project, August 26–29 2013.
- J. D. Hales, M. R. Tonks, K. Chockalingam, D. M. Perez, S. R. Novascone, and B. W. Spencer, “Multiscale nuclear fuel analysis via asymptotic expansion homogenization,” in *Transactions of SMiRT-22, I. A. for Structural Mechanics in Reactor Technology*, Ed., San Francisco, CA, August 18–23, 2013.

- S. R. Novascone, B. W. Spencer, R. L. Williamson, D. Andrs, J. D. Hales, and D. M. Perez, “The effects of thermomechanics coupling strategies in nuclear fuels performance simulations,” in *Transactions of SMiRT-22, I. A. for Structural Mechanics in Reactor Technology, Ed.*, San Francisco, CA, August 18–23, 2013.
- J. D. Hales, R. L. Williamson, S. R. Novascone, B. W. Spencer, D. M. Perez, and G. Pastore, “Computational challenges in modeling loss of coolant accidents,” in *12th US National Congress on Computational Mechanics*, ser. USNCCM12, Raleigh, NC, July 22–25 2013.
- G. Pastore, J. D. Hales, S. R. Novascone, D. M. Perez, B. W. Spencer, and R. L. Williamson, “Modeling of fission gas behavior in nuclear fuel applied to engineering scale analysis,” in *12th US National Congress on Computational Mechanics*, ser. USNCCM12, Raleigh, NC, July 22–25 2013.
- B. W. Spencer, J. D. Hales, S. R. Novascone, D. M. Perez, and R. L. Williamson, “Frictional contact in nuclear fuel simulations,” in *12th US National Congress on Computational Mechanics*, ser. USNCCM12, Raleigh, NC, July 22–25 2013.
- F. N. Gleicher, S. R. Novascone, B. W. Spencer, R. L. Williamson, R. C. Martineau, M. Rose, and T. Downar, “Coupling the core analysis program DeCART to the fuel performance program BISON,” in *Proceedings of the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, Sun Valley, Idaho, May 5-9, 2013.
- J. D. Hales, D. Andrs, and D. R. Gaston, “Algorithms for thermal and mechanical contact in nuclear fuel performance analysis,” in *Proceedings of the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, Sun Valley, Idaho, May 5-9, 2013.
- D. M. Perez, R. L. Williamson, S. R. Novascone, T. K. Larson, J. D. Hales, B. W. Spencer, and G. Pastore, “An evaluation of the nuclear fuel performance code BISON,” in *Proceedings of the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, Sun Valley, Idaho, May 5-9, 2013.
- S. R. Novascone, B. W. Spencer, D. Andrs, R. L. Williamson, J. D. Hales, and D. M. Perez, “Results from tight and loose coupled multiphysics in nuclear fuels performance simulations using BISON,” in *Proceedings of the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, Sun Valley, Idaho, May 5-9, 2013.
- L. P. Swiler, R. L. Williamson, and D. M. Perez, “Calibration of a fuel relocation model in BISON,” in *Proceedings of the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, Sun Valley, Idaho, May 5-9, 2013.
- J. D. Hales, D. M. Perez, R. L. Williamson, S. R. Novascone, B. W. Spencer, and R. C. Martineau, “Validation of the BISON 3D fuel performance code: Temperature comparisons for concentrically and eccentrically located fuel pellets,” in *Enlarged Halden Programme Group Meeting: Proceedings of the Fuels and Materials Sessions*, vol. HPR-378. Storefjell Resort Hotel, Norway: OECD Halden Reactor Project, March 10–15 2013.

- S. R. Novascone, J. D. Hales, B. W. Spencer, and R. L. Williamson, "Assessment of PCMI Simulation Using the Multidimensional Multiphysics BISON Fuel Performance Code," in *Proceedings of Top Fuel 2012*, Manchester, United Kingdom, September 2-6, 2012.
- B. W. Spencer, J. D. Hales, S. R. Novascone, and R. L. Williamson, "3D Simulation of Missing Pellet Surface Defects in Light Water Reactor Fuel Rods," in *Proceedings of Top Fuel 2012*, Manchester, United Kingdom, September 2-6, 2012.
- S. R. Novascone, R. L. Williamson, J. D. Hales, M. R. Tonks, D. R. Gaston, C. J. Permann, D. Andrs, and R. C. Martineau, "A Multidimensional and Multiphysics Approach to Nuclear Fuel Behavior Simulation," in *Proceedings of PHYSOR 2012*, A. N. Society, Ed., Knoxville, Tennessee, April 15-20, 2012.
- B. Wirth, D. Gaston, J. Hales, R. Martineau, R. Montgomery, Y. R. Rashid, and C. Stanek, "3-dimensional, high-resolution modeling of nuclear fuel performance: pellet clad interaction," in *TMS 2012*, Orlando, Florida, March 11-15 2012.
- J. Hales, D. Andrs, D. Gaston, S. Novascone, C. Permann, M. Tonks, and R. Williamson, "Fully coupled, implicit, 3-d, multi-physics for analysis of nuclear fuel," in *11th US National Congress on Computational Mechanics*, ser. USNCCM11, Minneapolis, MN, 2011.
- D. Gaston, C. Permann, D. Andrs, J. Peterson, M. Tonks, J. Hales, R. Williamson, and L. Guo, "Massively parallel multiphysics simulation using an object-oriented framework," in *The Second Annual CAES Workshop on Modeling, Simulation and Visualization*, Boise, ID, Sep 8-9 2011.
- R. L. Williamson and D. A. Knoll, "Enhancing the ABAQUS thermomechanics code to simulate steady and transient fuel rod behavior," in *Proceedings of Top Fuel*, 2009, paper 2072.